US009258552B2

(12) **United States Patent**
Mori

(10) **Patent No.: US 9,258,552 B2**
(45) **Date of Patent: *Feb. 9, 2016**

(54) **PLAYBACK DEVICE, COMPOUND-EYE IMAGE PICKUP DEVICE, PLAYBACK METHOD AND NON-TRANSITORY COMPUTER READABLE MEDIUM**

(71) Applicant: **FUJIFILM Corporation**, Tokyo (JP)

(72) Inventor: **Koji Mori**, Kurokawa-gun (JP)

(73) Assignee: **FUJIFILM Corporation**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 263 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/727,288**

(22) Filed: **Dec. 26, 2012**

(65) **Prior Publication Data**

US 2013/0113901 A1 May 9, 2013

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2011/059112, filed on Apr. 12, 2011.

(30) **Foreign Application Priority Data**

Jun. 30, 2010 (JP) 2010-149859

(51) **Int. Cl.**
H04N 13/04 (2006.01)
G03B 35/16 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04N 13/0425*** (2013.01); ***G03B 35/16*** (2013.01); ***G03B 35/24*** (2013.01); ***H04N 13/0018*** (2013.01); ***H04N 13/0022*** (2013.01); ***H04N 13/0232*** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,736,247 A * 4/1988 Graham G01S 17/48
348/139
2004/0057612 A1 3/2004 Tabata
(Continued)

FOREIGN PATENT DOCUMENTS

JP H10-40420 A 2/1998
JP 11-355808 A 12/1999
(Continued)

OTHER PUBLICATIONS

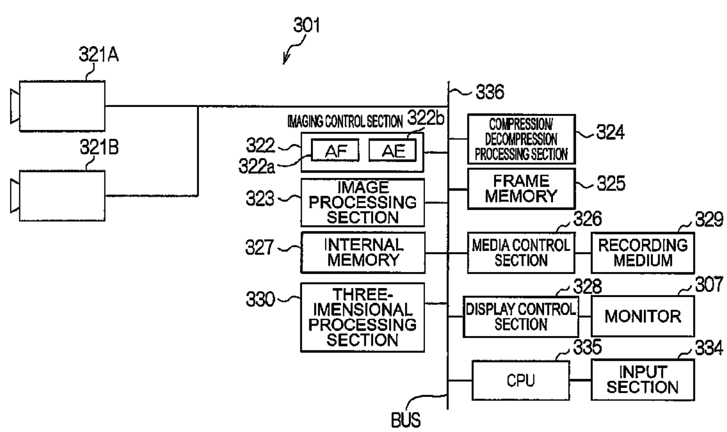
International Preliminary Report on Patentability issued in International Application No. PCT/JP2011/059112.
(Continued)

Primary Examiner — Sath V Perungavoor
Assistant Examiner — Dakshesh Parikh
(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

There is provided: a CPU that, in at least one case among a case in which fluctuation of a fixed interval in the acquired parallax amount is greater than a predetermined value, and a case in which the parallax amount reaches a predetermined allowed limit value, or a case in which an object of acquisition of the parallax amount can no longer be detected, judges that there is an abnormality in the parallax amount, and that, in a case that is none of these, judges that there is no abnormality in the parallax amount, and that, when it is judged that there is no abnormality in the parallax amount, carries out first parallax adjustment, and that, when it is judged that there is an abnormality in the parallax amount, switches to control of a second parallax adjustment and carries out parallax adjustment.

8 Claims, 17 Drawing Sheets



(51) **Int. Cl.**

G03B 35/24	(2006.01)
H04N 13/00	(2006.01)
H04N 13/02	(2006.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

2004/0208357	A1	10/2004	Tokuhashi et al.		
2005/0031330	A1*	2/2005	Nonaka	G03B 13/36	396/104
2005/0253924	A1*	11/2005	Mashitani	H04N 13/0275	348/42
2007/0296874	A1*	12/2007	Yoshimoto	G09G 3/003	348/739

FOREIGN PATENT DOCUMENTS

JP	2003-18619	A	1/2003
JP	2004-221700	A	8/2004
JP	2005-73012	A	3/2005
JP	2008-92515	A	4/2008

OTHER PUBLICATIONS

International Search Report issued in International Application No. PCT/JP2011/059112 mailed Jul. 12, 2011.

Chinese Office Action, dated Sep. 1, 2014, for Chinese Application No. 201180031764.1, including a partial English translation.

Chinese Office Action issued Sep. 16, 2015 in corresponding Chinese Application No. 201180031764.1.

* cited by examiner

FIG.1

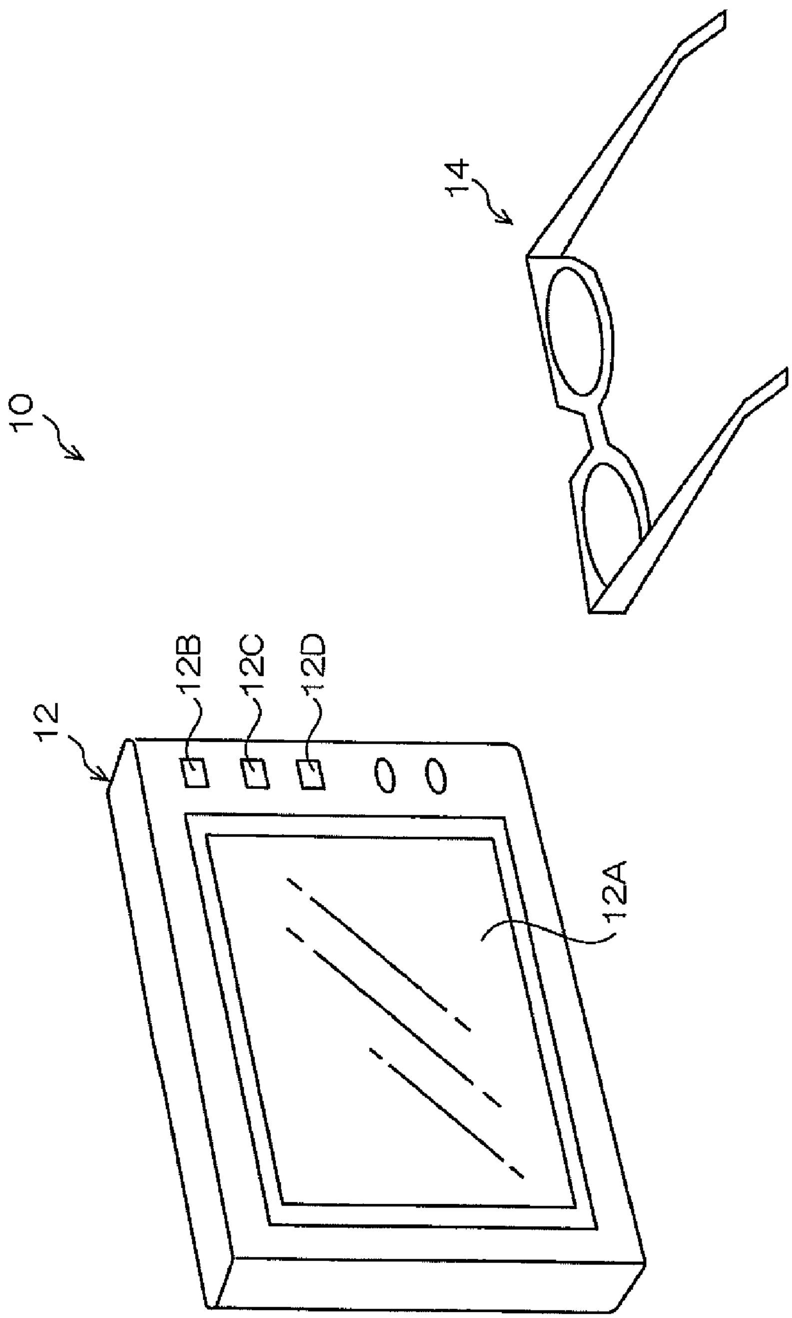


FIG.2

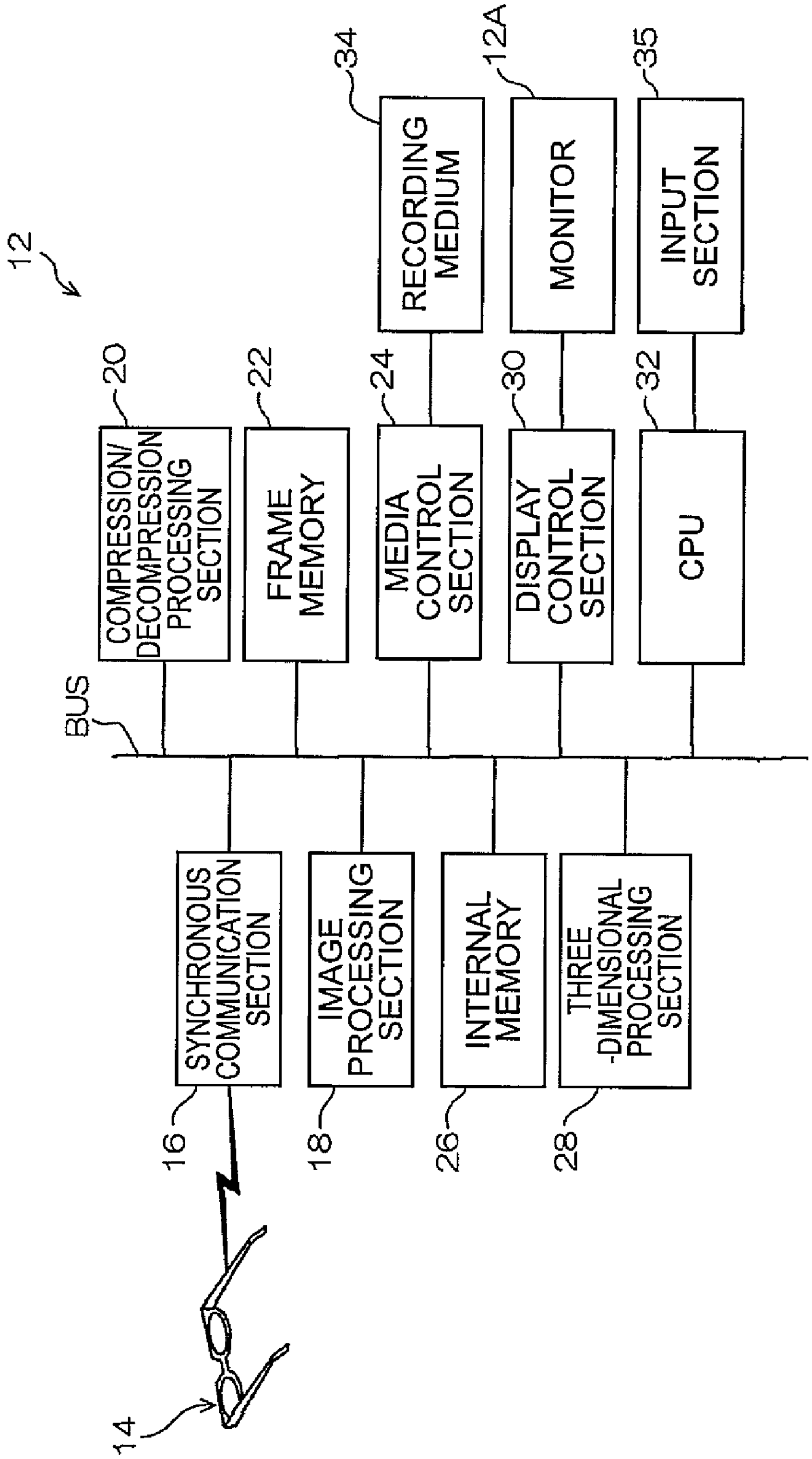

12
BUS
COMPRESSION/ DECOMPRESSION PROCESSING SECTION
20
FRAME MEMORY
22
MEDIA CONTROL SECTION
24
DISPLAY CONTROL SECTION
30
CPU
32
RECORDING MEDIUM
34
MONITOR
12A
INPUT SECTION
35
SYNCHRONOUS COMMUNICATION SECTION
16
IMAGE PROCESSING SECTION
18
INTERNAL MEMORY
26
THREE -DIMENSIONAL PROCESSING SECTION
28
14

FIG.3

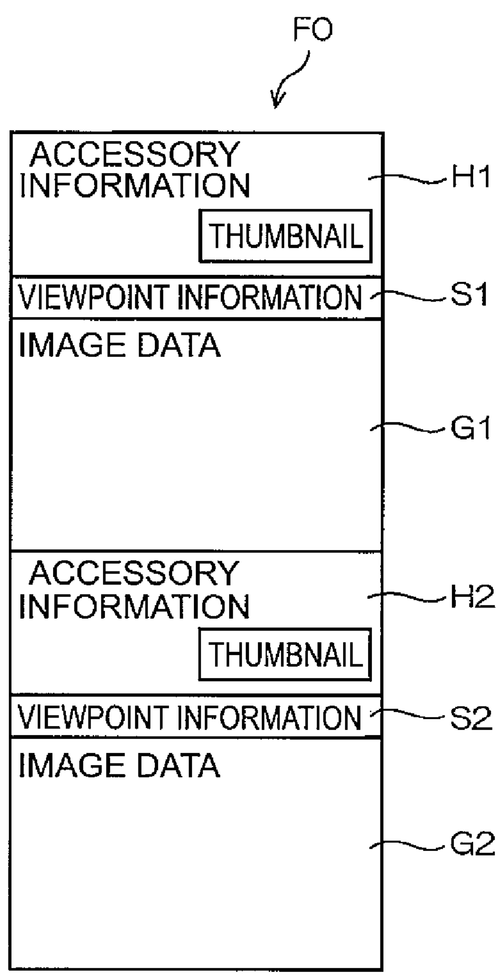

FO
ACCESSORY INFORMATION
THUMBNAIL
H1
VIEWPOINT INFORMATION
S1
IMAGE DATA
G1
ACCESSORY INFORMATION
THUMBNAIL
H2
VIEWPOINT INFORMATION
S2
IMAGE DATA
G2

FIG.4

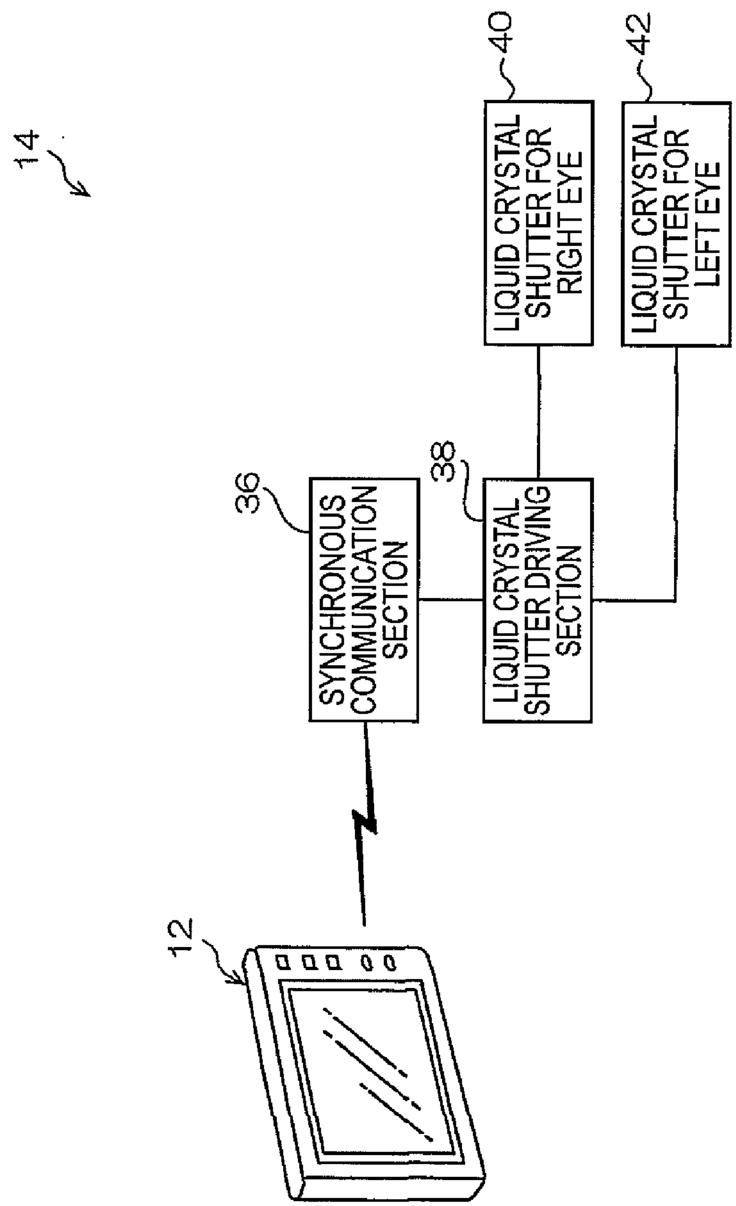
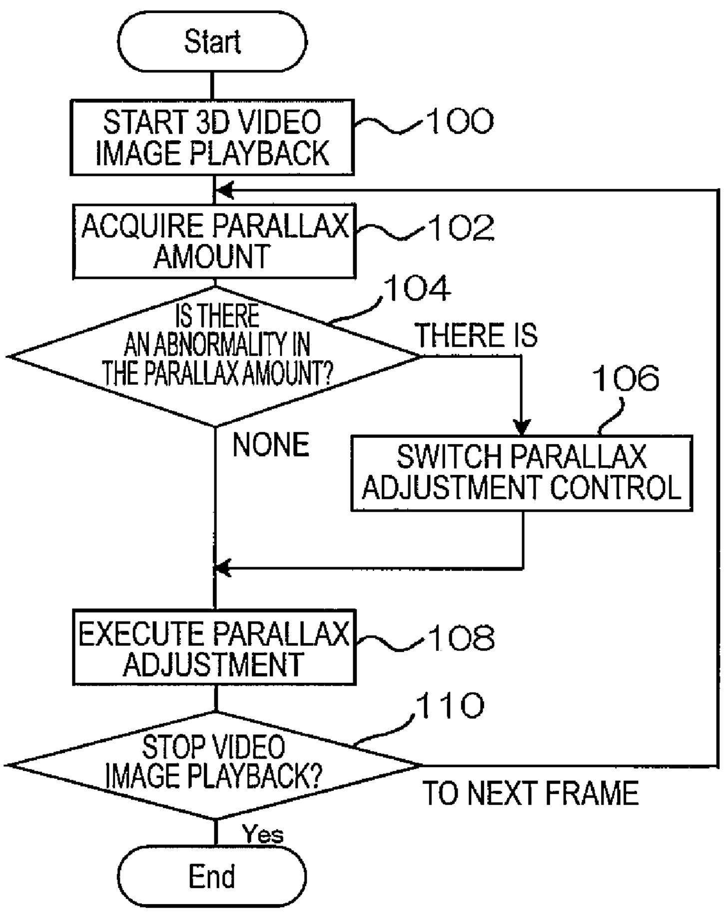

14
40
LIQUID CRYSTAL SHUTTER FOR RIGHT EYE
42
LIQUID CRYSTAL SHUTTER FOR LEFT EYE
36
SYNCHRONOUS COMMUNICATION SECTION
38
LIQUID CRYSTAL SHUTTER DRIVING SECTION
12

FIG.5



Start
START 3D VIDEO IMAGE PLAYBACK
100
ACQUIRE PARALLAX AMOUNT
102
104
IS THERE AN ABNORMALITY IN THE PARALLAX AMOUNT?
THERE IS
106
NONE
SWITCH PARALLAX ADJUSTMENT CONTROL
EXECUTE PARALLAX ADJUSTMENT
108
110
STOP VIDEO IMAGE PLAYBACK?
TO NEXT FRAME
Yes
End

FIG.6

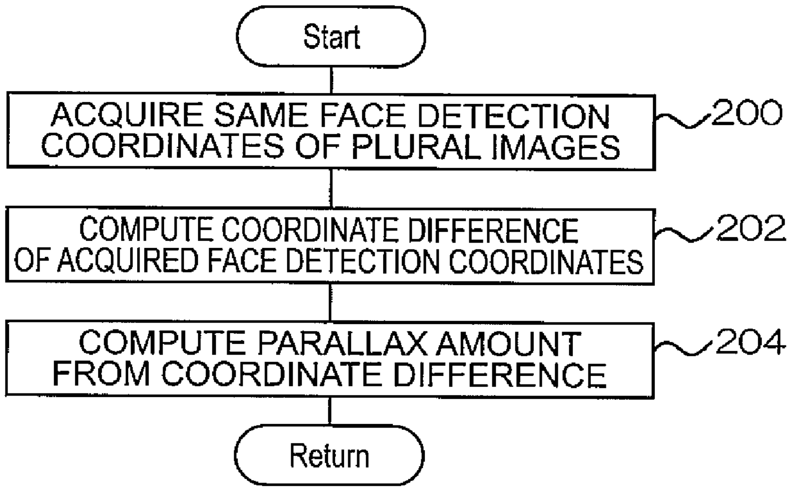

Start
ACQUIRE SAME FACE DETECTION COORDINATES OF PLURAL IMAGES
200
COMPUTE COORDINATE DIFFERENCE OF ACQUIRED FACE DETECTION COORDINATES
202
COMPUTE PARALLAX AMOUNT FROM COORDINATE DIFFERENCE
204
Return

FIG.7

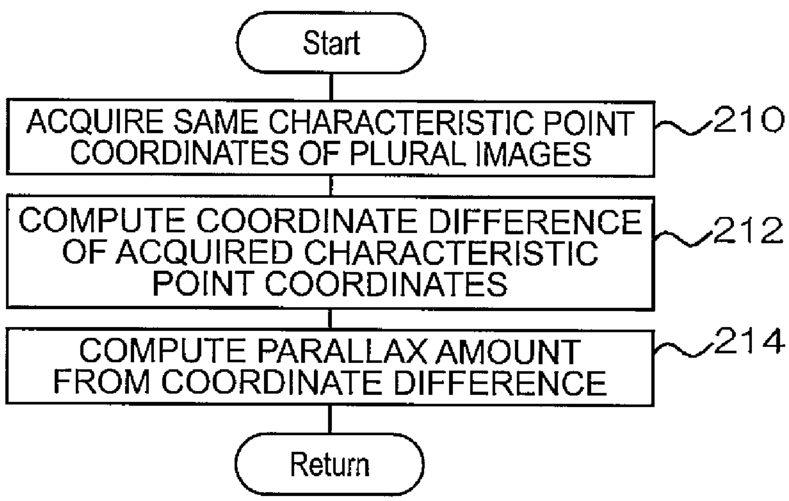

Start
ACQUIRE SAME CHARACTERISTIC POINT COORDINATES OF PLURAL IMAGES
210
COMPUTE COORDINATE DIFFERENCE OF ACQUIRED CHARACTERISTIC POINT COORDINATES
212
COMPUTE PARALLAX AMOUNT FROM COORDINATE DIFFERENCE
214
Return

FIG.8

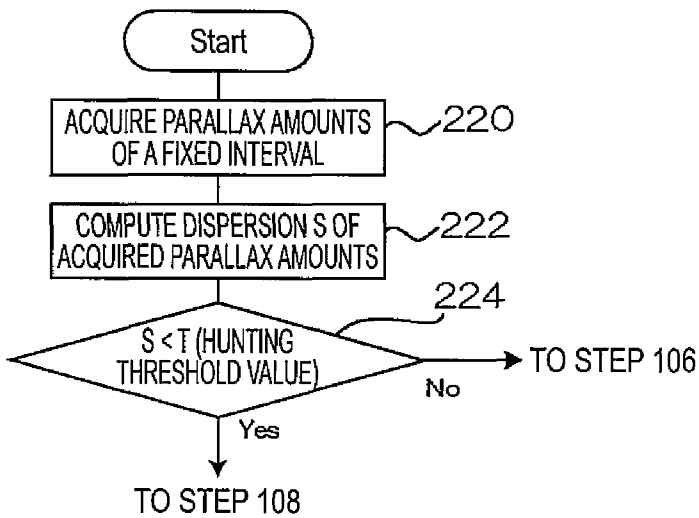

Start
ACQUIRE PARALLAX AMOUNTS OF A FIXED INTERVAL
220
COMPUTE DISPERSION S OF ACQUIRED PARALLAX AMOUNTS
222
224
S < T (HUNTING THRESHOLD VALUE)
No
TO STEP 106
Yes
TO STEP 108

FIG.9

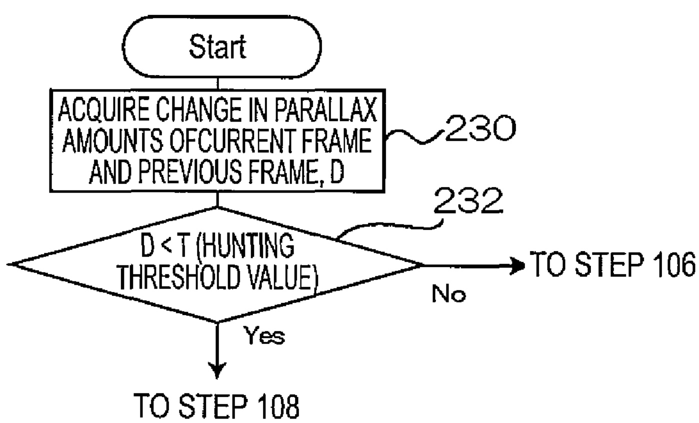
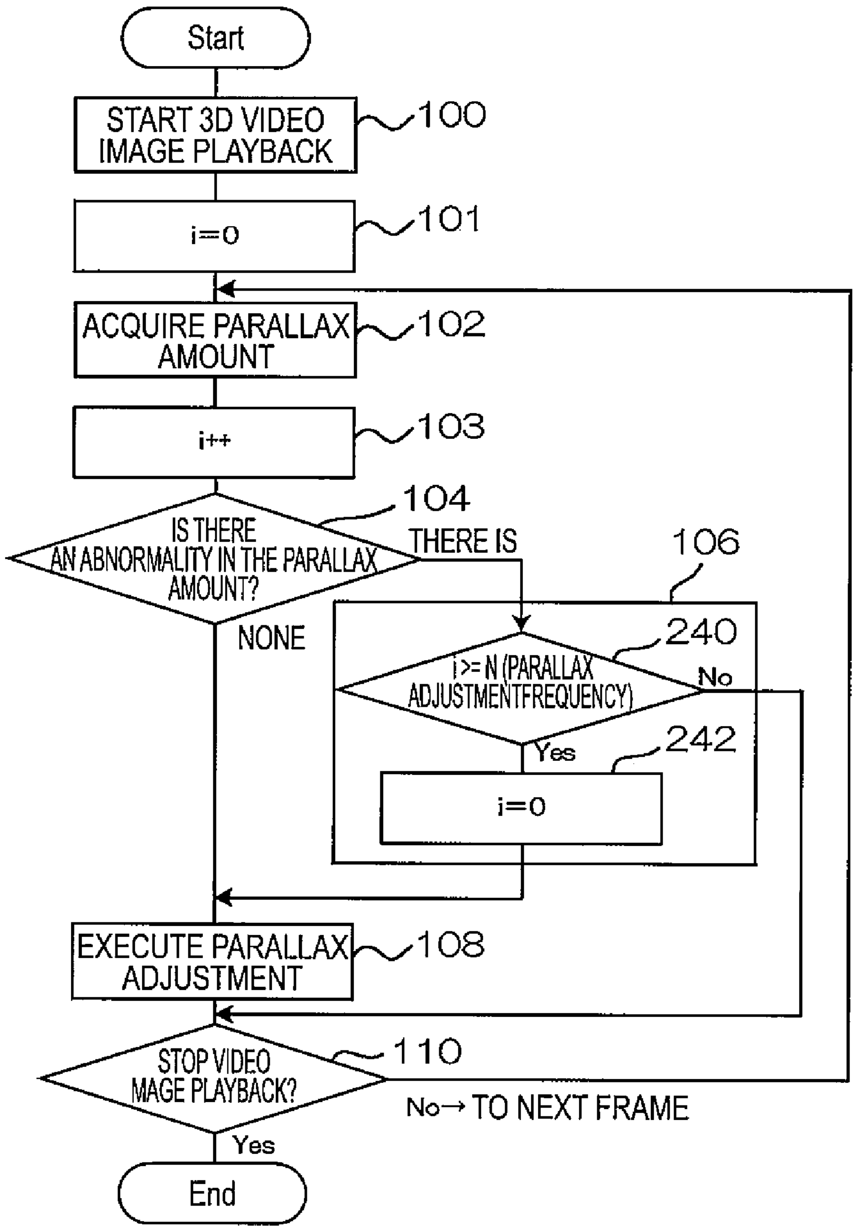
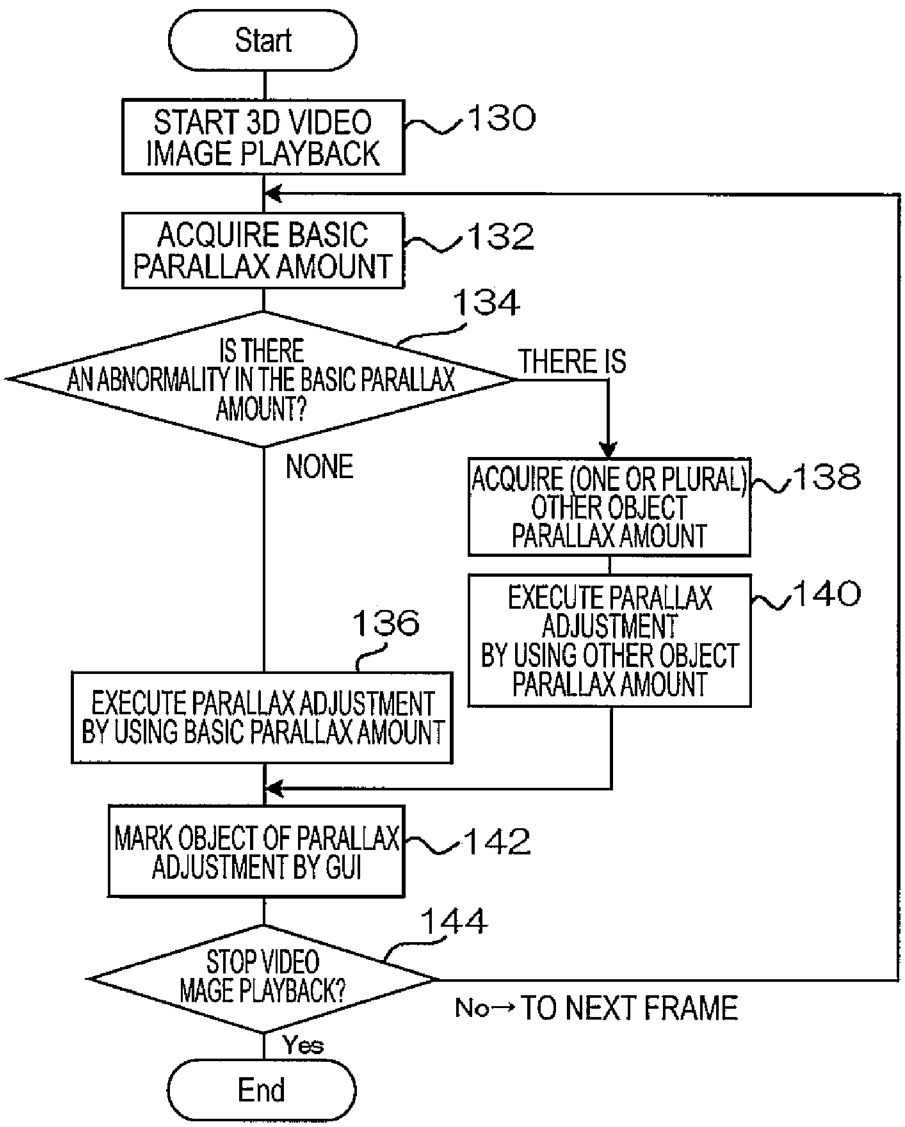

Start
ACQUIRE CHANGE IN PARALLAX AMOUNTS OFCURRENT FRAME AND PREVIOUS FRAME, D
230
232
D < T (HUNTING THRESHOLD VALUE)
No
TO STEP 106
Yes
TO STEP 108

FIG.10



Start
START 3D VIDEO IMAGE PLAYBACK
100
i=0
101
ACQUIRE PARALLAX AMOUNT
102
i++
103
IS THERE AN ABNORMALITY IN THE PARALLAX AMOUNT?
104
THERE IS
106
NONE
i>= N (PARALLAX ADJUSTMENTFREQUENCY)
240
No
Yes
242
i=0
EXECUTE PARALLAX ADJUSTMENT
108
STOP VIDEO MAGE PLAYBACK?
110
No→ TO NEXT FRAME
Yes
End

FIG.11



Start
START 3D VIDEO IMAGE PLAYBACK
130
ACQUIRE BASIC PARALLAX AMOUNT
132
134
IS THERE AN ABNORMALITY IN THE BASIC PARALLAX AMOUNT?
THERE IS
NONE
ACQUIRE (ONE OR PLURAL) OTHER OBJECT PARALLAX AMOUNT
138
EXECUTE PARALLAX ADJUSTMENT BY USING OTHER OBJECT PARALLAX AMOUNT
140
136
EXECUTE PARALLAX ADJUSTMENT BY USING BASIC PARALLAX AMOUNT
MARK OBJECT OF PARALLAX ADJUSTMENT BY GUI
142
144
STOP VIDEO MAGE PLAYBACK?
No→TO NEXT FRAME
Yes
End

FIG.12A

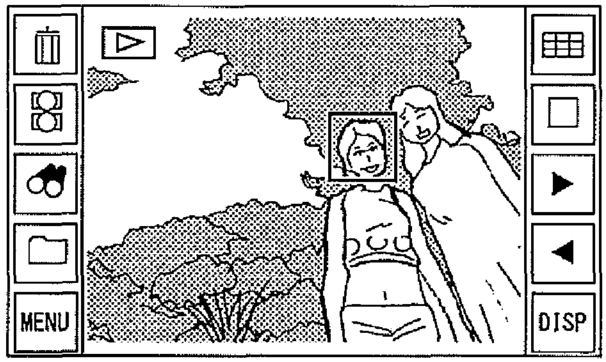


FIG.12B

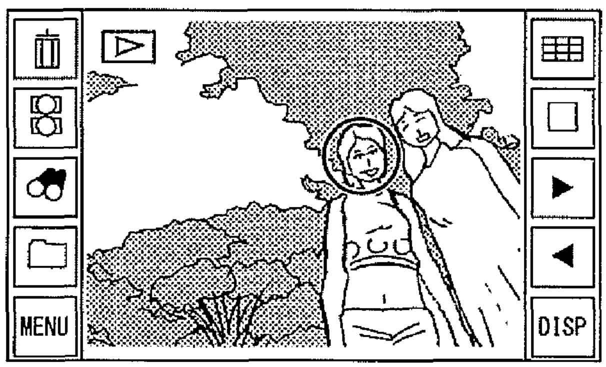


FIG.12C

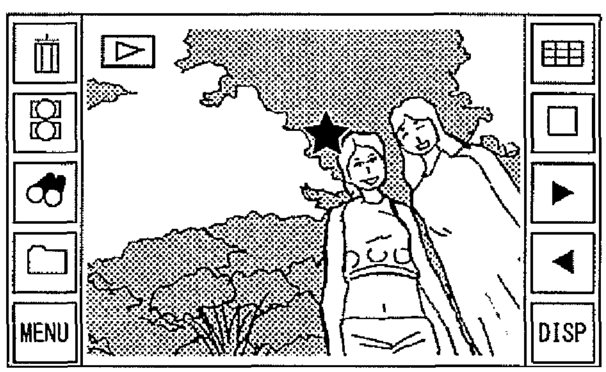


FIG.13

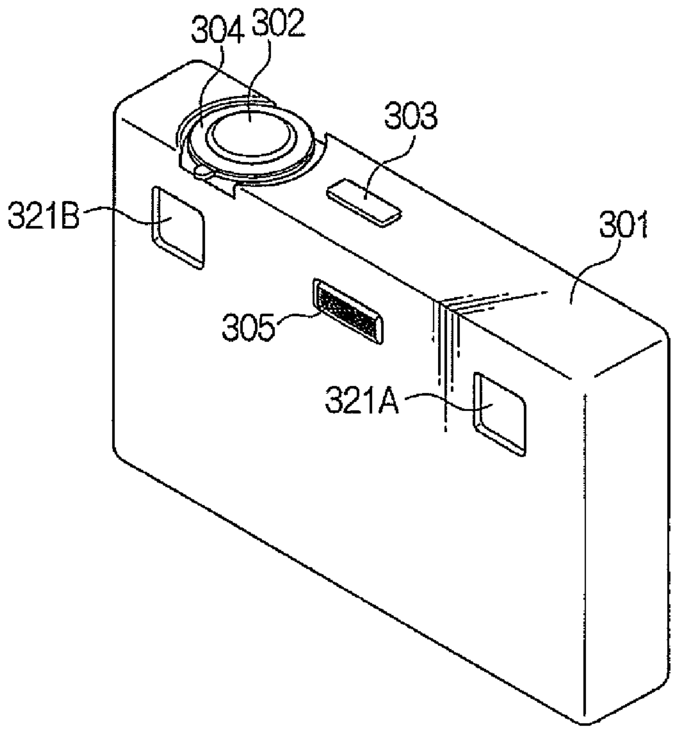


FIG.14

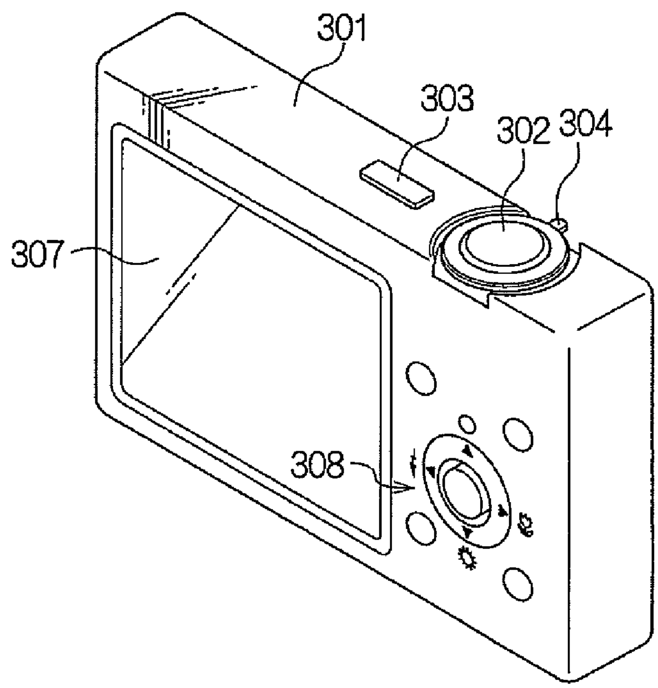
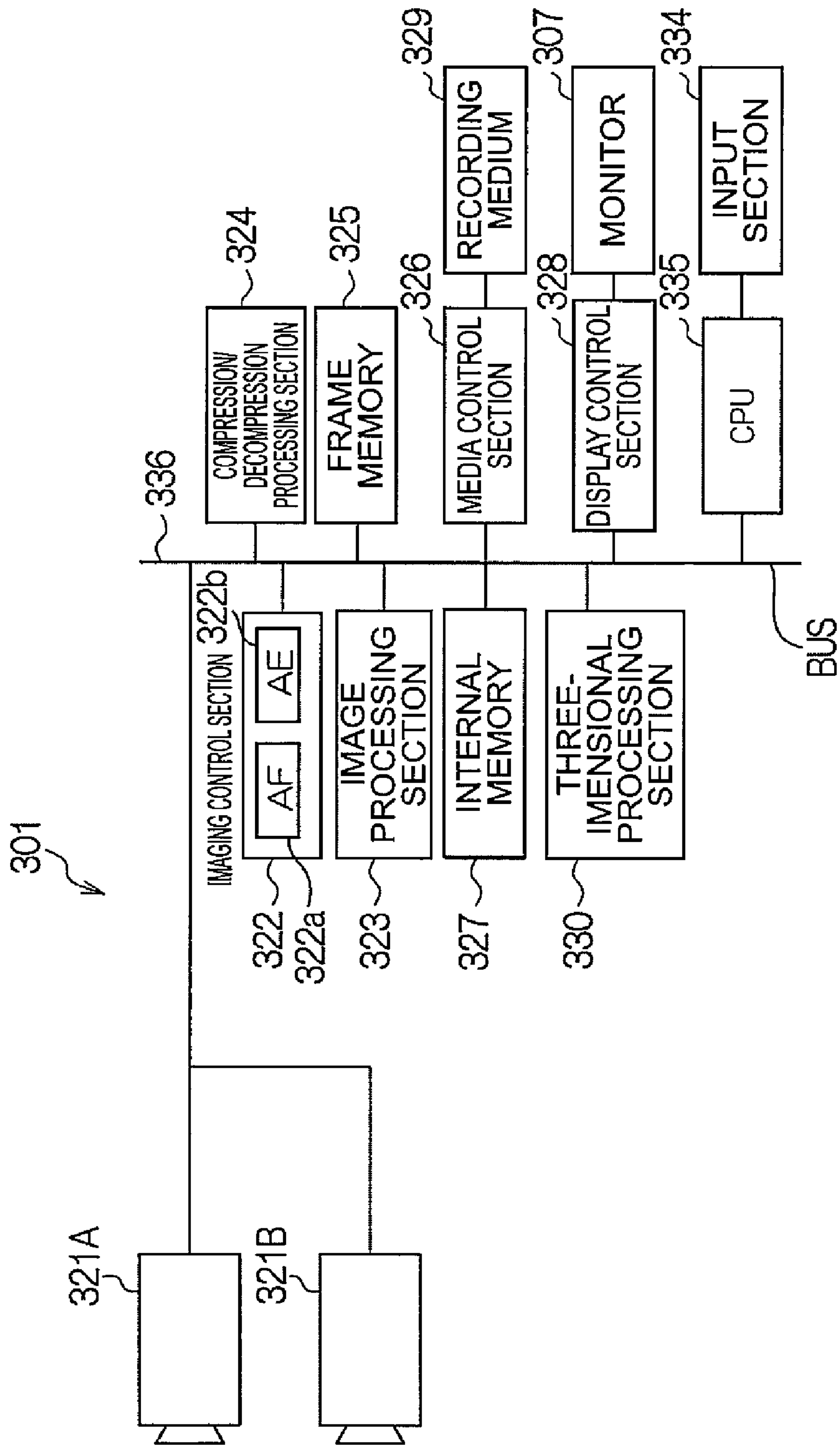


FIG.15



301
321A
321B
IMAGING CONTROL SECTION
AF
AE
322
322a
322b
IMAGE PROCESSING SECTION
323
INTERNAL MEMORY
327
THREE-IMENSIONAL PROCESSING SECTION
330
BUS
336
COMPRESSION/DECOMPRESSION PROCESSING SECTION
324
FRAME MEMORY
325
MEDIA CONTROL SECTION
326
RECORDING MEDIUM
329
DISPLAY CONTROL SECTION
328
MONITOR
307
CPU
335
INPUT SECTION
334

FIG.16

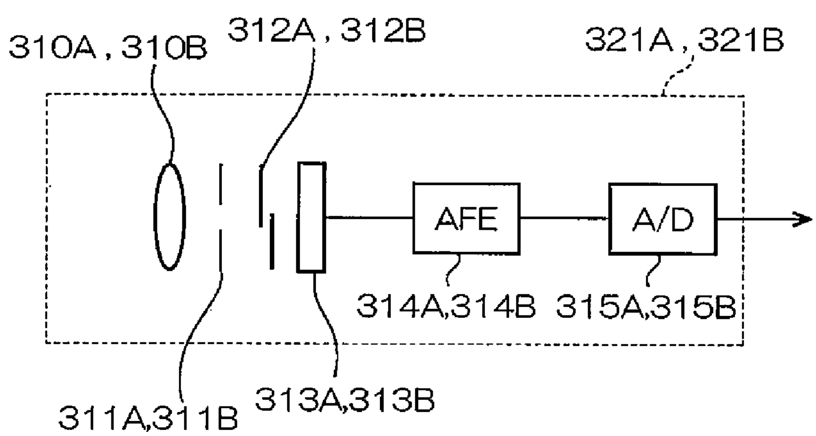

310A , 310B
312A , 312B
321A , 321B
AFE
A/D
314A,314B
315A,315B
311A,311B
313A,313B

FIG.17

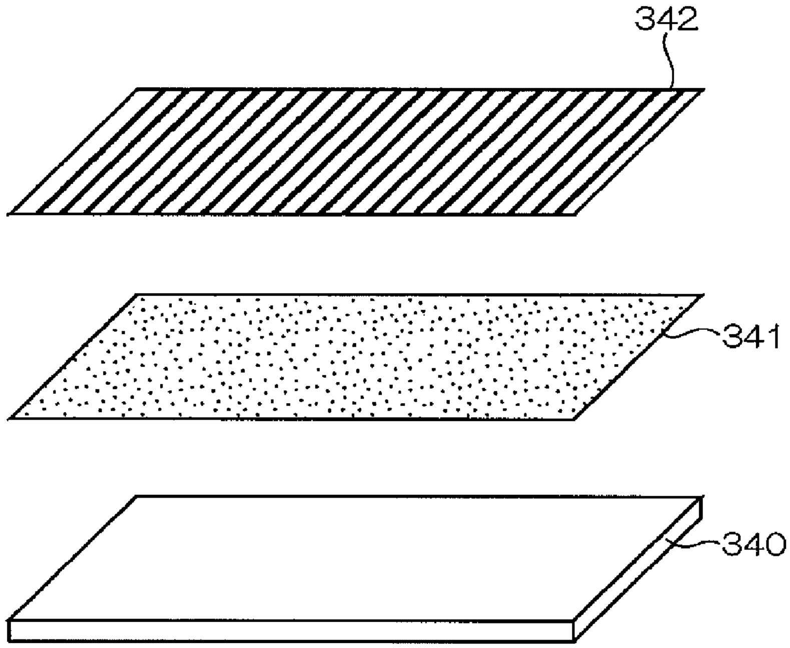


FIG.18

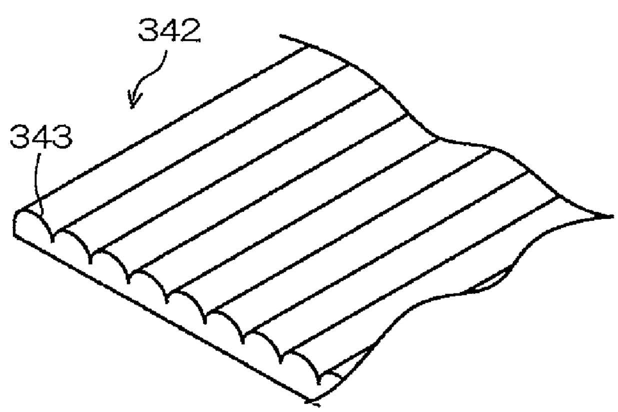


FIG.19

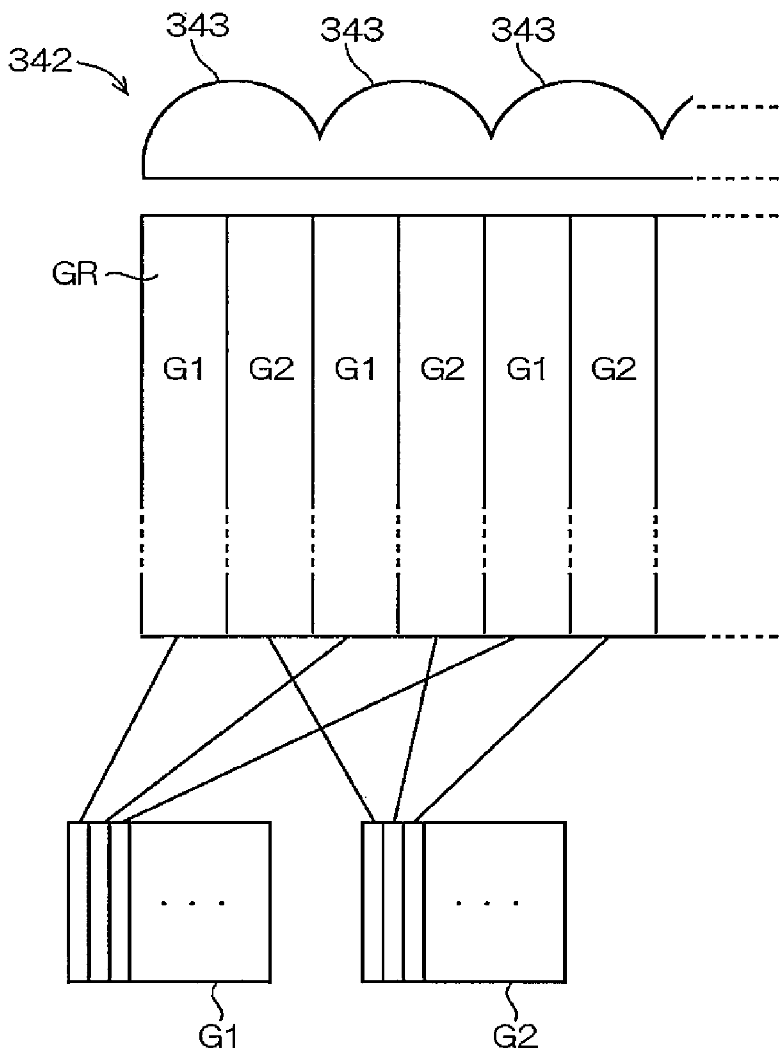


FIG.20

FIRST FRAME	LEFT EYE IMAGE	COORDINATE GROUP OF CHARACTERISTIC POINT A
		COORDINATE GROUP OF DETECTED FACE A
		COORDINATE GROUP OF DETECTED FACE B
		ABSENCE/PRESENCE OF HUNTING
		.
		.
	RIGHT EYE MAGE	COORDINATE GROUP OF CHARACTERISTIC POINT A′
		COORDINATE GROUP OF DETECTED FACE A′
		COORDINATE GROUP OF DETECTED FACE B′
		ABSENCE/PRESENCE OF HUNTING
		.
		.
SECOND FRAME	LEFT EYE IMAGE	COORDINATE GROUP OF CHARACTERISTIC POINT A
		COORDINATE GROUP OF DETECTED FACE A
		COORDINATE GROUP OF DETECTED FACE B
		ABSENCE/PRESENCE OF HUNTING
		.
		.
	RIGHT EYE MAGE	COORDINATE GROUP OF CHARACTERISTIC POINT A′
		COORDINATE GROUP OF DETECTED FACE A′
		COORDINATE GROUP OF DETECTED FACE B′
		ABSENCE/PRESENCE OF HUNTING
		.
		.
⋮	⋮	⋮
nTH FRAME	LEFT EYE IMAGE	COORDINATE GROUP OF CHARACTERISTIC POINT A
		COORDINATE GROUP OF DETECTED FACE A
		COORDINATE GROUP OF DETECTED FACE B
		ABSENCE/PRESENCE OF HUNTING
		.
		.
	RIGHT EYE MAGE	COORDINATE GROUP OF CHARACTERISTIC POINT A′
		COORDINATE GROUP OF DETECTED FACE A′
		COORDINATE GROUP OF DETECTED FACE B′
		ABSENCE/PRESENCE OF HUNTING
		.
		.

FIG.21A

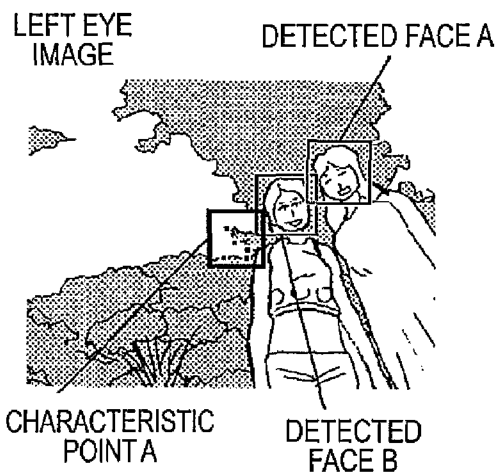
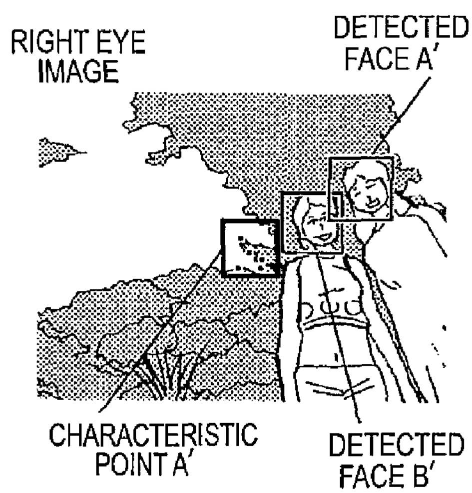


FIG.21B



PLAYBACK DEVICE, COMPOUND-EYE IMAGE PICKUP DEVICE, PLAYBACK METHOD AND NON-TRANSITORY COMPUTER READABLE MEDIUM

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation application of International Application No. PCT/JP2011/059112, filed Apr. 12, 2011, which is incorporated herein by reference. Further, this application claims priority from Japanese Patent Application No. 2010-149859, filed Jun. 30, 2010, which is incorporated herein by reference.

TECHNICAL FIELD

The present invention relates to a playback device, a compound-eye image pickup device, a playback method and a non-transitory computer readable medium.

BACKGROUND ART

There is conventionally proposed a compound-eye image pickup device that has plural image pickup sections and generates a stereoscopic image. The compound-eye image pickup device generates the stereoscopic image on the basis of plural viewpoint images that are generated by the plural image pickup sections respectively, and displays this stereoscopic image on a monitor for stereoscopic display.

The stereoscopic feel of the stereoscopic image that is picked-up at the compound-eye image pickup device depends on distance between the both eyes of the user and the distance from the monitor for stereoscopic display to the user, and therefore, there is the problem that, with regard to the stereoscopic function of the compound-eye image pickup device, differences between individuals are great. Thus, in a compound-eye image pickup device, the parallax of the plural viewpoint images can be adjusted in accordance with operation of the user, and the stereoscopic feel of the stereoscopic image is thereby adjusted.

Thus, in Japanese Patent Application Laid-Open No. 2005-73012 (hereinafter called Patent Document 1), there is disclosed a technique of carrying out parallax amount adjustment that suits the intentions of the user who carried out the parallax amount adjustment initially, regardless of the type of the display that displays the stereoscopic image.

In the technique of Patent Document 1, information relating to adjustment of the parallax amount is created on the basis of a request to change the parallax amount, and this is converted into information of a unit that does not depend on the type of the display, and is recorded. Then, when the recorded information is read-out, information relating to adjustment of the parallax amount is created on the basis of this information, and an image for stereoscopic display is generated on the basis of this information.

Further, in Japanese Patent Application Laid-Open No. 2004-221700 (hereinafter called Patent Document 2), there is disclosed a technique of specifying the parallax that suits the intentions of the user while the stereoscopic image is being displayed.

In the technique of Patent Document 2, the limit parallax of a stereoscopic image that was displayed on a display device is specified in accordance with the instruction of a user, and image processing is carried out so that the appropriate parallax is realized before the stereoscopic image is displayed.

However, when there are problems in the initial stage, e.g., when there are problems with the parallax amount itself that is determined from the plural viewpoint images obtained by the image pickup sections, or when the object of parallax adjustment can no longer be detected, there is the problem that parallax adjustment cannot be carried out appropriately even if the techniques of Patent Documents 1 and 2 are used.

The present invention is proposed in view of these circumstances, and an object thereof is to provide a playback device, a compound-eye image pickup device, a playback method and a non-transitory computer readable medium, that can carry out parallax adjustment appropriately even when there are problems with the parallax amount itself that is determined from plural viewpoint images or when the object of parallax adjustment can no longer be detected.

SUMMARY OF INVENTION

Solution to the Problem

A playback device relating to a first aspect of the present invention comprises: an input section that inputs continuous frame images of a plurality of viewpoints in which a same subject has been picked-up in continuous frames from a plurality of viewpoints; a parallax amount acquiring section that acquires a parallax amount on the basis of frame images that structure the continuous frame images inputted by the input section; an abnormality judging section that judges that there is an abnormality in the parallax amount in at least one case among a case in which fluctuation of a fixed interval in the parallax amount acquired by the parallax amount acquiring section is greater than a predetermined value, a case in which the parallax amount reaches an allowed limit value that has been determined in advance, or a case in which an object of acquisition of the parallax amount can no longer be detected; a parallax adjusting section that, when it is judged by the abnormality judging section that there is no abnormality in the parallax amount, carries out first parallax adjustment, and that, when it is judged by the abnormality judging section that there is an abnormality in the parallax amount, switches to control of a second parallax adjustment, that is different than control of the first parallax adjustment, and carries out parallax adjustment; and an output section that outputs the continuous frame images on which the parallax adjustment has been carried out by the parallax adjusting section.

In a second aspect of the present invention, in the first aspect of the present invention, when it is judged by the abnormality judging section that there is an abnormality in the parallax amount, the parallax adjusting section carries out parallax adjustment within a range of a parallax amount maximum change amount that has been determined in advance.

In a third aspect of the present invention, in the first aspect or the second aspect of the present invention, when it is judged by the abnormality judging section that there is an abnormality in the parallax amount, the parallax adjusting section carries out parallax adjustment by using a parallax amount of a previous frame.

In a fourth aspect of the present invention, in any one of the first aspect through the third aspect of the present invention, when it is judged by the abnormality judging section that there is an abnormality in the parallax amount, the parallax adjusting section lowers a parallax adjustment frequency.

In a fifth aspect of the present invention, in any one of the first aspect through the fourth aspect of the present invention, the parallax amount acquiring section acquires the parallax amount on the basis of a subject image that has been determined in advance as a subject image that is an object of acquisition of the parallax amount within the frame images.

In a sixth aspect of the present invention, in the fifth aspect of the present invention, the subject image that has been determined in advance is a subject image that is based on a closed curve region prescribed by a spatial frequency of a predetermined value within the frame images.

A seventh aspect of the present invention comprises: an input section that inputs continuous frame images of a plurality of viewpoints in which a same subject has been picked-up in continuous frames from a plurality of viewpoints; a parallax amount acquiring section that acquires a parallax amount of a predetermined object on the basis of frame images that structure the continuous frame images inputted by the input section; an abnormality judging section that judges that there is an abnormality in the parallax amount in at least one case among a case in which fluctuation of a fixed interval in the parallax amount acquired by the parallax amount acquiring section is greater than a predetermined value, a case in which the parallax amount reaches an allowed limit value that has been determined in advance, or a case in which an object of acquisition of the parallax amount can no longer be detected; a parallax adjusting section that, when it is judged by the abnormality judging section that there is no abnormality in the parallax amount, carries out parallax adjustment of the predetermined object, and that, when it is judged by the abnormality judging section that there is an abnormality in the parallax amount, carries out parallax adjustment with respect to another object that is different than the predetermined object; and an output section that, when it is judged by the abnormality judging section that there is no abnormality in the parallax amount, outputs the frame images that include the predetermined object on which parallax adjustment has been carried out by the parallax adjusting section, and that, when it is judged by the abnormality judging section that there is an abnormality in the parallax amount, outputs the frame images that include the other object on which parallax adjustment has been carried out by the parallax adjusting section.

In an eighth aspect of the present invention, in the seventh aspect of the present invention, the parallax adjusting section makes an object, that has a closest distance to the predetermined object in a direction orthogonal to an image plane of the frame images, be the other object.

In a ninth aspect of the present invention, in the seventh aspect of the present invention, the parallax adjusting section makes an object, that has a closest distance to the predetermined object in an image plane of the frame images, be the other object.

In a tenth aspect of the present invention, in any one of the seventh aspect through the ninth aspect of the present invention, at least one of the predetermined object o r the other object is a subject image that is based on a closed curve region prescribed by a spatial frequency of a predetermined value within the frame images.

In an eleventh aspect of the present invention, in any one of the first aspect through the tenth aspect of the present invention, there is further comprised a display section that displays the frame images, that are outputted by the output section, such that the frame images are viewed as a stereoscopic image.

A twelfth aspect of the present invention comprises: the playback device of any one of the first aspect through the eleventh aspect of the present invention; and an image pickup section that generates the continuous frame images by picking-up a same subject from a plurality of viewpoints in continuous frames.

A thirteenth aspect of the present invention: inputs continuous frame images of a plurality of viewpoints in which a same subject has been picked-up in continuous frames from a plurality of viewpoints; acquires a parallax amount on the basis of frame images that structure the inputted continuous frame images; judges that there is an abnormality in the parallax amount in at least one case among a case in which fluctuation of a fixed interval in the acquired parallax amount is greater than a predetermined value, a case in which the parallax amount reaches an allowed limit value that has been determined in advance, or a case in which an object of acquisition of the parallax amount can no longer be detected; when it is judged that there is no abnormality in the parallax amount, carries out first parallax adjustment, and, when it is judged that there is an abnormality in the parallax amount, switches to control of a second parallax adjustment, that is different than control of the first parallax adjustment, and carries out parallax adjustment; and outputs the continuous frame images on which the parallax adjustment has been carried out.

A fourteenth aspect of the present invention: inputs continuous frame images of a plurality of viewpoints in which a same subject has been picked-up in continuous frames from a plurality of viewpoints; acquires a parallax amount of a predetermined object on the basis of frame images that structure the inputted continuous frame images; judges that there is an abnormality in the parallax amount in at least one case among a case in which fluctuation of a fixed interval in the acquired parallax amount is greater than a predetermined value, a case in which the parallax amount reaches an allowed limit value that has been determined in advance, or a case in which an object of acquisition of the parallax amount can no longer be detected; when it is judged that there is no abnormality in the parallax amount, carries out parallax adjustment of the predetermined object, and, when it is judged that there is an abnormality in the parallax amount, carries out parallax adjustment with respect to another object that is different than the predetermined object; and when it is judged that there is no abnormality in the parallax amount, outputs the frame images that include the predetermined object on which the parallax adjustment has been carried out, and, when it is judged that there is an abnormality in the parallax amount, outputs the frame images that include the other object on which the parallax adjustment has been carried out.

A fifteenth aspect of the present invention is for causing a computer to function as: an input section that inputs continuous frame images of a plurality of viewpoints in which a same subject has been picked-up in continuous frames from a plurality of viewpoints; a parallax amount acquiring section that acquires a parallax amount on the basis of frame images that structure the continuous frame images inputted by the input section; an abnormality judging section that judges that there is an abnormality in the parallax amount in at least one case among a case in which fluctuation of a fixed interval in the parallax amount acquired by the parallax amount acquiring section is greater than a predetermined value, a case in which the parallax amount reaches an allowed limit value that has been determined in advance, or a case in which an object of acquisition of the parallax amount can no longer be detected; a parallax adjusting section that, when it is judged by the abnormality judging section that there is no abnormality in the parallax amount, carries out first parallax adjustment, and that, when it is judged by the abnormality judging section that there is an abnormality in the parallax amount, switches to control of a second parallax adjustment, that is different than control of the first parallax adjustment, and carries out parallax adjustment; and an output section that outputs the continuous frame images on which the parallax adjustment has been carried out by the parallax adjusting section.

A sixteenth aspect of the present invention is for causing a computer to function as: an input section that inputs continuous frame images of a plurality of viewpoints in which a same subject has been picked-up in continuous frames from a plurality of viewpoints; a parallax amount acquiring section that acquires a parallax amount of a predetermined object on the basis of frame images that structure the continuous frame images inputted by the input section; an abnormality judging section that judges that there is an abnormality in the parallax amount in at least one case among a case in which fluctuation of a fixed interval in the parallax amount acquired by the parallax amount acquiring section is greater than a predetermined value, a case in which the parallax amount reaches an allowed limit value that has been determined in advance, or a case in which an object of acquisition of the parallax amount can no longer be detected; a parallax adjusting section that, when it is judged by the abnormality judging section that there is no abnormality in the parallax amount, carries out parallax adjustment of the predetermined object, and that, when it is judged by the abnormality judging section that there is an abnormality in the parallax amount, carries out parallax adjustment with respect to another object that is different than the predetermined object; and an output section that, when it is judged by the abnormality judging section that there is no abnormality in the parallax amount, outputs the frame images that include the predetermined object on which parallax adjustment has been carried out by the parallax adjusting section, and that, when it is judged by the abnormality judging section that there is an abnormality in the parallax amount, outputs the frame images that include the other object on which parallax adjustment has been carried out by the parallax adjusting section.

Advantageous Effects of the Invention

In accordance with the present invention, parallax adjustment can be carried out appropriately even when there are problems with the parallax amount itself that is determined from plural viewpoint images or when the object of parallax adjustment can no longer be detected.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a perspective view showing a summary of a stereoscopic image playback device.

FIG. **2** is a block diagram showing the schematic structure of a display device side of the stereoscopic image playback device.

FIG. **3** is a drawing showing the file format of an image file for stereoscopic viewing.

FIG. **4** is a block diagram showing the schematic structure of a liquid crystal shutter glasses side of the stereoscopic image playback device.

FIG. **5** is a flowchart showing a first parallax adjusting routine.

FIG. **6** is a flowchart showing a first parallax amount acquisition routine.

FIG. **7** is a flowchart showing a second parallax amount acquisition routine.

FIG. **8** is a flowchart showing a first hunting absence/presence judging routine.

FIG. **9** is a flowchart showing a second hunting absence/presence judging routine.

FIG. **10** is a flowchart showing a second parallax adjusting routine.

FIG. **11** is a flowchart showing a third parallax adjusting routine.

FIG. **12**A is a drawing showing a state in which an object of parallax adjustment is marked by a GUI.

FIG. **12**B is a drawing showing a state in which the object of parallax adjustment is marked by a GUI.

FIG. **12**C is a drawing showing a state in which the object of parallax adjustment is marked by a GUI.

FIG. **13** is a front perspective view of a compound-eye camera.

FIG. **14** is a rear perspective view of the compound-eye camera.

FIG. **15** is a schematic block diagram showing the internal structure of the compound-eye camera.

FIG. **16** is a diagram showing the structure of an imaging section.

FIG. **17** is a drawing showing the structure of a monitor.

FIG. **18** is a drawing showing the structure of a lenticular sheet.

FIG. **19** is a diagram for explaining three-dimensional processing with respect images for a left eye and for a right eye.

FIG. **20** is a drawing showing an example of parallax related information.

FIG. **21**A is a drawing for explaining parallax related information.

FIG. **21**B is a drawing for explaining parallax related information.

DESCRIPTION OF EMBODIMENTS

First Embodiment

FIG. **1** is a drawing showing a summary of a stereoscopic image playback device **10** relating to a first embodiment of the present invention.

As shown in this drawing, the stereoscopic image playback device **10** relating to the present first embodiment has a display device **12** that displays stereoscopic images and liquid crystal shutter glasses **14**. Further, the display device **12** has a monitor **12**A that carries out various types of display, a power button **12**B, a playback start button **12**C, and a playback stop button **12**D.

Note that, in the present first embodiment, description is given by using, as an example, a form in which a three-dimensional stereoscopic image is played-back so as to be seen as a stereoscopic image by a method in which an image G**1** for the left eye and an image G**2** for the right eye are displayed alternately on the display device **12**, and liquid crystal shutters are driven alternately such that the right-eye liquid crystal shutter of the liquid crystal shutter glasses **14** is in a transmitting state when the image G**1** for the left eye is displayed, and the left-eye liquid crystal shutter of the liquid crystal shutter glasses **14** is in a transmitting state when the image G**2** for the right eye is displayed. Note that, in the present first embodiment, a stereoscopic image playback device, that plays back three-dimensional stereoscopic images by using the liquid crystal shutter glasses **14**, is described as an example, but the present invention is not limited to this, and, for example, may be applied to a device that plays back three-dimensional stereoscopic images by using polarizing filter glasses, or may be applied to a stereoscopic image playback device of a method that plays back three-dimensional stereoscopic images by a method that does not utilize glasses.

FIG. **2** is a block diagram showing the schematic structure of the display device **12** side of the stereoscopic image playback device **10** relating to the present first embodiment.

The display device **12** has a synchronous communication section **16**, an image processing section **18**, a compression/decompression processing section **20**, a frame memory **22**, a media control section **24**, an internal memory **26**, a three-dimensional processing section **28**, a display control section **30**, and a CPU **32**. These are connected to one another via a bus BUS. Further, a recording medium **34** is connected to the media control section **24**, and the monitor **12**A is connected to the display control section **30**, respectively. Moreover, an input section **35**, that is structured to include the power button **12**B, the playback start button **12**C and the playback stop button **12**D, is connected to the CPU **32**.

The synchronous communication section **16** carries out transmission and receipt of signals for synchronizing driving of the left and right liquid crystal shutters of the liquid crystal shutter glasses **14**, and the respective images for the left eye and the right eye that are displayed on the display device **12**.

The image processing section **18** carries out various types of image processings, such as white balance adjustment, gradation correction, sharpness correction, color correction, and the like on the image data that expresses the image that is to be displayed.

The compression/decompression processing section **20** carries out compression processing in a compression format such as, for example, JPEG or MPEG or the like, on the image data subjected to processing by the image processing section **18**, so as to generate an image file F**0** for stereoscopic viewing, and, at the time of playback, carries out decompression processing on compressed image data. The image file F**0** has the image data of the image G**1** for the left eye and the image G**2** for the right eye, and further includes accessory information that is based on Exif format for example, such as the baseline length, the convergence angle, the image capturing date and time and the like, and viewpoint information expressing the viewpoint positions.

FIG. **3** is a drawing showing the file format of the image file for stereoscopic viewing. Accessory information H**1** of the image G**1** for the left eye, viewpoint information S**1** of the image G**1** for the left eye, image data of the image G**1** for the left eye, accessory information H**2** of the image G**2** for the right eye, viewpoint information S**2** of the image G**2** for the right eye, and image data of the image G**2** for the right eye are stored in the image file F**0** for stereoscopic viewing. Further, although not illustrated, information expressing the start position and the end position of the data are included before and after the accessory information, the viewpoint information and the image data of the images G**1**, G**2** for the left eye and the right eye.

Information of the image capturing date, the baseline length, and the convergence angle of the images G**1**, G**2** for the left eye and the right eye is included in the accessory information H**1**, H**2**. Thumbnail images of the images G**1**, G**2** for the left eye and the right eye also are included in the accessory information H**1**, H**2**. Note that the number of the viewpoint position, that is given in order from the imaging section at the left side for example, can be used as the viewpoint information.

The frame memory **22** is a memory for work that is used at the time of carrying out various types of processings that carry out the processings that the image processing section **18** carries out, on the image data.

The media control section **24** carries out control of accessing the recording medium **34** and, for example, writing and reading image files.

The internal memory **26** stores, for example, information that expresses the various settings at the display device **12**, and programs that the CPU **32** executes.

The three-dimensional processing section **28** reads-out the image data stored on the recording medium **34**, and controls the display control section such that a stereoscopic image GR is displayed by alternately displaying the image G**1** for the left eye and the image G**2** for the right eye that are for displaying a stereoscopic image, synchronously with a synchronization signal that is obtained by the synchronous communication section **16** by communication with the liquid crystal shutter glasses **14**. Further, when parallax information per frame is not recorded in the image data, the three-dimensional processing section **28** detects the main subject, and carries out processing that computes the parallax per frame. Further, the three-dimensional processing section **28** can also adjust the parallax of the image G**1** for the left eye and the image G**2** for the right eye. Here, parallax means the amount of offset of the pixel positions in the lateral direction of the image G**1** for the left eye and the image G**2** for the right eye, i.e., in the direction along the base line, of the subject that is included in both the image G**1** for the left eye and the image G**2** for the right eye. By adjusting the parallax, the stereoscopic feel of the subject that is included in the stereoscopic image GR can be made to be an appropriate feel.

In the case of stereoscopic viewing, the display control section **30** displays the image G**1** for the left eye and the image G**2** for the right eye alternately on the monitor **12**A in accordance with control of the three-dimensional processing section **28**.

FIG. **4** is a block diagram showing the schematic structure at the liquid crystal shutter glasses **14** side of the stereoscopic image playback device **10** relating to the first embodiment.

The liquid crystal shutter glasses **14** have a synchronous communication section **36**, a liquid crystal shutter driving section **38**, a liquid crystal shutter **40** for the right eye, and a liquid crystal shutter **42** for the left eye.

The synchronous communication section **36** communicates signals for synchronizing the driving of the left and right liquid crystal shutters, and the respective left and right images that are displayed on the display device **12**.

The liquid crystal shutter driving section **38** controls the driving of the liquid crystal shutter **40** for the right eye and the liquid crystal shutter **42** for the left eye, synchronously with a synchronization signal obtained by communication with the display device **12** by the synchronous communication section **36**. Due thereto, when the image G**1** for the left eye is being displayed on the monitor **12**A of the display device **12**, the liquid crystal shutter **40** for the right eye is in a transmitting state and the liquid crystal shutter **42** for the left eye is in a blocking state, and, when the image G**2** for the right eye is being displayed on the monitor **12**A of the display device **12**, the liquid crystal shutter **42** for the left eye is in a transmitting state and the liquid crystal shutter **40** for the right eye is in a blocking state, and stereoscopic images are played-back.

The following first or second parallax adjusting routine is executed at the display device **12** that is structured as described above. Note that the programs of the first and second parallax adjusting routines are stored in advance in the internal memory **26**.

(First Parallax Adjusting Routine)

FIG. **5** is a flowchart showing the first parallax adjusting routine.

In step **100**, when an instruction to start video image playback is inputted via the playback start button **12**C, the CPU **32** starts three-dimensional video image playback, and the routine proceeds to step **102**.

In step **102**, the CPU **32** causes the three-dimensional processing section **28** to acquire a parallax amount that is based on the images G**1**, G**2** for the left eye and the right eye of the image file F0 stored in the recording medium 34. Here, a first or second parallax amount acquiring routine is executed, and the three-dimensional processing section 30 carries out the following processing.

(Acquiring of Parallax Amount)

FIG. 6 is a flowchart showing the first parallax amount acquiring routine. Initially, the three-dimensional processing section 28 respectively detects the face region of a same person in plural images, i.e., the images G1, G2 for the left eye and the right eye of the image file F0 stored in the recording medium 34, and acquires face detection coordinates that express the coordinates of these face regions (step 200), and computes a coordinate difference of the acquired face detection coordinates (step 202), and computes a parallax amount from the coordinate difference (step 204).

FIG. 7 is a flowchart showing the second parallax amount acquiring routine. Initially, the three-dimensional processing section 30 respectively detects a same object in plural images, i.e., the images G1, G2 for the left eye and the right eye of the image file F0 stored in the recording medium 34, and acquires characteristic point coordinates that are the coordinates of characteristic points that specify these objects (step 210), and computes the coordinate difference of the acquired characteristic point coordinates (step 212), and computes a parallax amount from the coordinate difference (step 214). Then, when the first or second parallax amount acquiring routine ends, the routine moves on to step 104 shown in FIG. 5.

(Judgment as to Abnormality of Parallax Amount)

In step 104, the CPU 32 judges whether or not there is an abnormality in the parallax amount acquired at the three-dimensional processing section 28. When it is judged that there is an abnormality, the routine proceeds to step 106, and when it is judged that there is no abnormality, the routine proceeds to step 108. Here, abnormality of the parallax amount is judged on the basis of any one of (1) whether or not there is hunting in the parallax amount, (2) whether the parallax amount is the allowed limit, and (3) whether the object of parallax adjustment has been lost track of and can no longer be detected.

(1) Judgment as to Absence/Presence of Hunting

In step 104, the CPU 32 executes a first or second hunting absence/presence judging routine that are shown next. Note that the programs for the left eye and of the second hunting absence/presence judging routine are stored in advance in the internal memory 26.

FIG. 8 is a flowchart showing the first hunting absence/presence judging routine. The CPU 32 acquires parallax amounts of a fixed interval that are obtained at the three-dimensional processing section 28 (step 220), and computes dispersion S of the acquired parallax amounts (step 222). Then, the CPU 35 judges whether the dispersion S is smaller than a hunting threshold value T (S<T) (step 224). When S<T, it is judged that there is no hunting (there is no abnormality in the parallax amount), and the routine proceeds to step 108 of FIG. 5. When S is not <T, it is judged that there is hunting (there is an abnormality in the parallax amount), and the routine proceeds to step 106 of FIG. 5.

FIG. 9 is a flowchart showing the second hunting absence/presence judging routine. The CPU 32 acquires a change amount D in the parallax amount of the current frame and the previous frame obtained at the three-dimensional processing section 28 (step 230). Then, the CPU 32 judges whether the change amount D is smaller than the hunting threshold value T (S<T) (step 232). When D<T, it is judged that there is no hunting (there is no abnormality in the parallax amount), and the routine proceeds to step 108 of FIG. 5. When D is not <T, it is judged that there is hunting (there is an abnormality in the parallax amount), and the routine proceeds to step 106 of FIG. 5.

(2) Judgment as to Allowed Limit of Parallax Amount

In step 104, the CPU 32 may judge whether the parallax amount has reached an allowed limit value that is set in advance. Here, the allowed limit means a threshold value of the parallax amount that indicates too much jumping-out or too much sinking-in of the object expressed by the stereoscopic image. When the parallax amount has reached the allowed limit value, the routine proceeds to step 106. When the parallax amount has not reached the allowed limit value, the routine proceeds to step 108.

(3) Judgment as to Object of Parallax Adjustment

In step 104, the CPU 32 may judge whether or not the object of parallax adjustment has been lost track of and can no longer be detected. An object or plural characteristic points or the like that are in the vicinity of the central position of the screen, such as, for example, the face of a person or the like, corresponds to the object of parallax adjustment.

Here, when the object of parallax adjustment has not been detected in 10 frames for example, the CPU 32 judges that the object of parallax adjustment has been lost track of, and the routine proceeds to step 106. When the object of parallax adjustment is not detected in 10 frames, the routine proceeds to step 108. Note that "10 frames" is merely an example, and another number of frames may be used. Due thereto, when the object of parallax adjustment is lost track of, the parallax adjustment control is switched, and therefore, parallax adjustment of three-dimensional video image playback can be stabilized.

(Switching of Parallax Adjustment Control)

In step 106, the CPU 32 switches the parallax adjustment control to another control. Here, any one processing among first through third switching processings is executed.

As the first switching processing, the CPU 32 limits the amount of change in the parallax amount per frame by defining a parallax amount maximum change amount per frame and setting it at the three-dimensional processing section 28. Due thereto, parallax adjustment is carried out within the range of the parallax amount maximum change amount, and sudden changes in the parallax amount can be suppressed, and therefore, parallax adjustment of three-dimensional video image playback can be stabilized.

Further, as the second switching processing, the CPU 32 skips parallax adjustment at the frame in question (prohibits parallax adjustment at the frame in question), and continues the parallax adjustment of the previous frame as is. Namely, the parallax amount at the previous frame is used. Due thereto, even when there is an abnormality in the parallax amount, because parallax adjustment can be skipped, parallax adjustment of three-dimensional video image playback can be stabilized.

Moreover, as the third switching processing, the CPU 32 reduces the frequency of executing parallax adjustment. Here, the second parallax adjusting routine shown in following FIG. 10 is executed instead of the parallax adjusting routine shown in FIG. 5. Note that steps that are the same as steps of FIG. 5 are denoted by the same reference numerals, and repeat description is omitted.

The parallax adjusting routine of FIG. 10 differs from FIG. 5 with regard to the point that index number i is set to i=0 after step 100 (step 101), and i is incremented by 1 (i++) after step 102 (step 103). Further, in step 106 in which the third switching processing is carried out, the following processing is carried out.

First, the CPU **32** judges whether the index number i is greater than or equal to parallax adjustment frequency N (i≥N) (step **240**). Then, when i≥N, the CPU **32** sets i=0 (step **242**), and proceeds to step **108**. When i is not ≥N, the CPU **32** skips step **108** and proceeds to step **110**.

Therefore, when the index number i is less than N, steps **102**, **103**, **104**, **106** (step **240**), **110** are executed repeatedly, and parallax adjustment (step **108**) is not carried out. Further, when the index number i reaches N, the routine proceeds to step **108** through steps **104**, **106** (steps **240**, **242**), and therefore, parallax adjustment is executed.

Accordingly, when there is an abnormality in the parallax, the parallax is adjusted one time each N frames, and the parallax is not adjusted each frame. Therefore, the frequency of parallax adjustment is reduced, and changes in the parallax adjustment can be made to be gentle.

In step **108**, the CPU **32** causes the three-dimensional processing section **28** to execute parallax adjustment, and outputs the images G**1**, G**2** for the left eye and the right eye, whose parallax has been adjusted, to the display control section **30**, and proceeds to step **110**.

In step **110**, the CPU **32** judges whether an instruction to stop video image playback has been inputted from the playback stop button **12**D. When the judgment is affirmative, the CPU **32** ends the present routine. When the judgment is negative, the CPU **32** shifts to processing of the next frame, and returns to step **102** again.

As described above, even when there is an abnormality in the parallax amount or when the parallax object has been lost track of, the stereoscopic image playback device **10** relating to the present first embodiment carries out parallax adjustment after switching the parallax adjustment control. Therefore, parallax adjustment of three-dimensional video image playback can be stabilized.

Note that, when the CPU **32** detects hunting, the CPU **32** may, after executing parallax adjustment (after step **108** ends), record, in the recording medium **34**, hunting information that expresses the absence/presence of hunting. Due thereto, because the absence/presence of hunting is added to the video image information, the CPU **32** can utilize the hunting information at times of video playback again, and parallax adjustment at the time of three-dimensional video playback again can be stabilized. Further, a case is described in which, in step **104**, any one of (1) judgment as to the absence/presence of hunting, (2) judgment as to the allowed limit of the parallax amount, and (3) judgment as to the object of parallax adjustment, is executed, but it suffices for at least one of (1) through (3) to be executed. Moreover, a case is described in which, in step **106**, any one processing among the first through third switching processings is executed, but it suffices for at least one processing among the first through third switching processings to be executed.

Second Embodiment

A second embodiment of the present invention is described next. Note that regions that are the same as the first embodiment are denoted by the same reference numerals, and detailed description thereof is omitted. In the first embodiment, the first or second parallax adjusting routine is executed, but, in the second embodiment, the following third parallax adjusting routine is executed instead of the first or second parallax adjusting routine.

(Third Parallax Adjusting Routine)

FIG. **11** is a flowchart showing the third parallax adjusting routine.

In step **130**, when an instruction to start video image playback is inputted via the playback start button **12**C, the CPU **32** starts three-dimensional video image playback, and proceeds to step **132**.

In step **132**, the CPU **32** causes the three-dimensional processing section **28** to acquire a basic parallax amount that is based on the images G**1**, G**2** for the left eye and the right eye of the image file F**0** stored in the recording medium **34**, and proceeds to step **134**. Here, the basic parallax amount means the parallax amount of a default object, and means the parallax amount of, for example, the object that is nearest to the center of the screen.

In step **134**, the CPU **32** judges whether or not there is an abnormality in the basic parallax amount acquired at the three-dimensional processing section **28**. Here, the same processing as step **104** shown in FIG. **5** is executed. Then, when there is an abnormality in the basic parallax amount, the routine proceeds to step **138**. When there is no abnormality, the routine proceeds to step **136**.

In step **136**, the CPU **32** controls the three-dimensional processing section **28** to execute parallax adjustment by using the basic parallax amount, and proceeds to step **142**. In accordance with the present step **136**, the three-dimensional processing section **28** carries out parallax adjustment by using the basic parallax amount of the images G**1**, G**2** for the left eye and the right eye, and outputs the images G**1**, G**2** for the left eye and the right eye, whose parallax has been adjusted, to the display control section **30**.

On the other hand, in step **138**, the CPU **32** causes the three-dimensional processing section **28** to acquire the parallax amount of another object, and proceeds to step **138**. For example, the face of a person other than the default object, or the like, corresponds to the other object.

In step **140**, the three-dimensional processing section **28** is controlled so as to execute parallax adjustment by using the parallax amount of the other object. At this time, the three-dimensional processing section **28** selects, as the "other object", an "object that is near to the default object in the Z direction", or an "object that is near to the default object in the two-dimensional coordinate", and carries out parallax adjustment by using the parallax amount of the selected object, and outputs the object, whose parallax has been adjusted, to the display control section **30**. Here, the same plane as the images G**1**, G**2** for the left eye and the right eye of the image file F**0** stored in the recording medium **34** is expressed by a two-dimensional coordinate (X, Y), and the direction orthogonal to this plane (the baseline) is the Z direction.

Accordingly, although it does not matter whether or not the "object that is near to the default object in the Z direction" is near in the two-dimensional coordinate, it is the object whose stereoscopic feel is nearest to the default object. Therefore, due to the three-dimensional processing section **28** carrying out parallax adjustment by using the parallax amount of that object, the three-dimensional processing section **28** can suppress sudden changes in the parallax amount, and as a result, can stably carry out parallax adjustment.

Further, although it does not matter whether or not the "object that is near to the default object in the two-dimensional coordinate" is near to the stereoscopic feel of the default object, it is the object that is closest to the default object in the two-dimensional coordinate. Therefore, due to the three-dimensional processing section **28** carrying out parallax adjustment by using the parallax amount of that object, the three-dimensional processing section **28** can carry out parallax adjustment by using an object that is close to the object of parallax adjustment until now, and as a result, can stably carry out parallax adjustment. Then, the routine proceeds to step **142** via the above-described processings.

In step **142**, the CPU **32** marks the object of parallax adjustment by a GUI (Graphical User Interface) and causes the monitor **7** to display it, and proceeds to step **144**. Here, the face of the person that is the object of parallax adjustment may be, for example, surrounded by a square as shown in FIG. **12**A, or surrounded by a circle as shown in FIG. **12**B, or a star-shaped mark may be applied thereto as shown in FIG. **12**C.

In step **144**, the CPU **32** judges whether an instruction to stop video image playback has been inputted from the playback stop button **12**D. When the judgment is affirmative, the CPU **32** ends the present routine. When the judgment is negative, the CPU **32** shifts to processing to the next frame, and again returns to step **132**.

As described above, even when there is an abnormality in the basic parallax amount of the default object or when the default object has been lost track of, the playback device of the second embodiment carries out parallax adjustment after switching the object of parallax adjustment to another object. Therefore, parallax adjustment of three-dimensional video image playback can be stabilized.

Third Embodiment

A third embodiment of the present invention is described next with reference to the drawings. FIG. **13** is a front perspective view of a compound-eye camera **301** relating to an embodiment of the present invention, and FIG. **14** is a rear perspective view.

A release button **302**, a power button **303** and a zoom lever **304** are provided at the top portion of the compound-eye camera **301**. A flash **305** and the lenses of two imaging sections **321**A, **321**B are disposed at the front surface of the compound-eye camera **301**. Further, a liquid crystal monitor (hereinafter simply called “monitor”) **307** that carries out various types of display, and various types of operation buttons **308**, that include buttons functioning also as the playback start button **12**C and the playback stop button **12**D described in the first and second embodiments, are disposed at the rear surface of the compound-eye camera **301**.

FIG. **15** is a schematic block diagram showing the internal structure of the compound-eye camera **301**. The compound-eye camera **301** has the two imaging sections **321**A, **321**B, an imaging control section **322**, an image processing section **323**, a compression/decompression processing section **324**, a frame memory **325**, a media control section **326**, an internal memory **327**, a display control section **328**, and a CPU **335**, and these are connected to one another via the bus BUS. Further, a recording medium **329** is connected to the media control section **326**, and the monitor **307** is connected to the display control section **328**, respectively. Moreover, an input section **334**, that is structured to include the release button **302**, the power button **303**, the zoom lever **304** and the operation buttons **308**, is connected to the CPU **32**. Note that the imaging sections **321**A, **321**B are disposed at a convergence angle at which the subject is viewed, such that there is a predetermined baseline length. Further, the information of the convergence angle and the baseline length is stored in the internal memory **327**.

FIG. **16** is a drawing showing the structure of the imaging sections **321**A, **321**B. As shown in FIG. **16**, the imaging section **321**A, **321**B has a lens **310**A, **310**B, a diaphragm **311**A, **311**B, a shutter **312**A, **312**B, an image pickup element **313**A, **313**B, an analog front end (AFE) **314**A, **314**B, and an A/D converting section **315**A, **315**B, respectively.

The lens **310**A, **310**B has plural function-specific lenses, such as a focus lens for focusing on the subject, a zoom lens for realizing the zoom function, and the like. The position of the lens **310**A, **310**B is adjusted by an unillustrated lens driving section on the basis of focus data obtained from an AF processing section **322***a* of the imaging control section **322**, and zoom data that is obtained when the zoom lever **304** shown in FIG. **13** and FIG. **14** is operated.

With respect to the diaphragm **311**A, **311**B, adjustment of the diaphragm diameter is carried out by an unillustrated diaphragm driving section on the basis of diaphragm value data obtained by an AE processing section **322***b* of the imaging control section **322**.

The shutter **312**A, **312**B is a mechanical shutter, and is driven by an unillustrated shutter driving section in accordance with a shutter speed obtained from the AE processing section **322***b*.

The image pickup element **313**A, **313**B has a photoelectric surface at which numerous light-receiving elements are arrayed two-dimensionally. The subject light is imaged on this photoelectric surface and photoelectrically converted, and analog imaging signals are acquired. Further, a color filter, in which filters of the respective colors of R, G, B are arrayed orderly, is disposed at the front surface of the image pickup element **313**A, **313**B.

The AFE **314**A, **314**B carries out, on the analog imaging signals outputted from the image pickup element **313**A, **313**B, processing that removes noise of the analog imaging signals, and processing that adjusts the gain of the analog imaging signals (hereinafter called “analog processings”).

The A/D converting section **315**A, **315**B converts, into digital signals, the analog imaging signals that were subjected to the analog processings by the AFE **314**A, **314**B. Note that the image expressed by the digital image data acquired from the imaging section **321**A is the image G**1** for the left eye, and the image expressed by the image data acquired from the imaging section **321**B is the image G**2** for the right eye.

As described above, the imaging control section **322** has the AF processing section **322***a* and the AE processing section **322***b*. When the release button **302** is halfway push-operated, the AF processing section **322***a* acquires ranging information from a ranging sensor, and determines the focal point positions of the lenses **10**A, **10**B, and outputs them to the imaging sections **321**A, **321**B. The AE processing section **322***b* determines the diaphragm value and the shutter speed on the basis of a pre-image, and outputs them to the imaging sections **321**A, **321**B.

Note that the method of detecting the focal point positions by the AF processing section **322***a* is not limited to an active method using ranging information, and a passive method that detects the focus positions by using the contrasts of the images may be used.

The imaging control section **322** controls the imaging sections **321**A, **321**B such that, in the state in which the release button **302** is not operated, through-images, that have fewer pixels than the actual images of the images G**1**, G**2** for the left eye and the right eye and are for confirming the imaging range, are successively generated at a predetermined time interval (e.g., an interval of 1/30 second). Then, when the release button **302** is fully press-operated, the imaging control section **322** controls the imaging sections **321**A, **321**B to generate the actual images of the images G**1**, G**2** for the left eye and the right eye in order to start the actual imaging.

The above explanation is the case of a static image mode, but, in the present third embodiment, setting to a video imaging mode is also possible. In the case of the video imaging mode, when the release button **302** is pushed, video imaging is started, and the images G1, G2 for the left eye and the right eye are generated per frame, and, when the release button 302 is pressed again, the video imaging stops.

The image processing section 323 carries out image processings such as white balance adjustment, gradation correction, sharpness correction, and color correction and the like on the digital image data of the images G1, G2 for the left eye and the right eye that the imaging sections 321A, 321B have acquired.

The compression/decompression processing section 324 carries out compression processing in a compression format such as, for example, JPEG or the like, on the image data expressing the actual images of the images G1, G2 for the left eye and the right eye that have been subjected to processing by the image processing section 323, and generates the image file F0 for stereoscopic viewing. This image file F0 for stereoscopic viewing has the image data of the images G1, G2 for the left eye and the right eye, and further includes accessory information that is based on Exif format or the like, such as the baseline length, the convergence angle, the image capturing date and time and the like, and viewpoint information expressing the viewpoint positions.

The frame memory 325 is a memory for work that is used when carrying out various types of processings, including the processings that the aforementioned image processing section 323 carries out, on the image data expressing the images G1, G2 for the left eye and the right eye that the imaging sections 321A, 321B acquired.

The media control section 326 carries out control of accessing the recording medium 329 and writing and reading image files and the like.

The internal memory 327 stores various types of constants that are set at the compound-eye camera 301, and programs that the CPU 335 executes, and the like.

In the case of stereoscopic viewing, the display control section 328 displays, on the monitor 307, the stereoscopic image GR that is recorded in the frame memory 325 or the recording medium 329.

FIG. 17 is an exploded perspective view showing the structure of the monitor 307. As shown in FIG. 17, the monitor 307 is structured by layering a backlight unit 340, that emits light from LEDs, and a liquid crystal panel 341, that is for carrying out various types of display, and mounting a lenticular sheet 342 to the obverse of the liquid crystal panel 341.

FIG. 18 is a drawing showing the structure of the lenticular sheet. As shown in FIG. 18, the lenticular sheet 342 is structured by lining-up plural cylindrical lenses 343 in parallel in a direction running along the baseline.

Further, the compound-eye camera 301 has a three-dimensional processing section 330. In order to stereoscopically display the images G1, G2 for the left eye and the right eye on the monitor 307, the three-dimensional processing section 330 carries out three-dimensional processing on the images G1, G2 for the left eye and the right eye, and generates the stereoscopic image GR.

FIG. 19 is a diagram for explaining three-dimensional processing with respect to the images G1, G2 for the left eye and the right eye. As shown in FIG. 19, the three-dimensional processing section 330 carries out the three-dimensional processing of cutting the images G1, G2 for the left eye and the right eye out respectively in strip shapes in the direction perpendicular to the baseline, and alternately disposing, at the respective cylindrical lenses 343 at the lenticular sheet 342, the images G1, G2 for the left eye and the right eye, that have been cut-out in strip shapes and whose positions correspond, and generates the stereoscopic image GR. The image pairs of the images G1, G2 for the left eye and the right eye that structure the stereoscopic image GR are each disposed so as to correspond to one cylindrical lens.

Further, the three-dimensional processing section 330 can also adjust the parallax of the images G1, G2 for the left eye and the right eye. Here, parallax means the offset amount in the pixel position in the lateral direction of the images G1, G2 for the left eye and the right eye, i.e., the direction along the baseline, of a subject that is included in both of the images G1, G2 for the left eye and the right eye. By adjusting the parallax, the stereoscopic feel of the subject that is included in the stereoscopic image GR can be made to be an appropriate feel.

Moreover, the three-dimensional processing section 330 may adjust in real time the parallax of the images G1, G2 for the left eye and the right eye obtained at the imaging sections 321A, 321B, or may adjust the parallax of the images G1, G2 for the left eye and the right eye that are recorded in advance on the recording medium 329.

In the compound-eye camera 301 that is structured as described above, the first or second parallax adjusting routine that was described in the first embodiment, or the third parallax adjusting routine that was described in the second embodiment, is executed. Note that the programs for the left eye and of the second parallax adjusting routine are stored in advance in the internal memory 327.

Note that the present invention is not limited to the above-described embodiments, and can also be applied to structures whose design has been changed within the scope of the matter recited in the claims.

For example, in the above-described first and second embodiments, parallax related information, such as shown in FIG. 20 as an example, may be acquired instead of directly acquiring the parallax amount.

FIG. 21A and FIG. 21B are drawings for explaining the parallax related information. Information such as the coordinate group of a characteristic point A, the coordinate group of a characteristic face A, the coordinate group of a characteristic face B, the absence/presence of hunting, for the left eye image (the image G1 for the left eye) and the right eye image (the image G2 for the right eye) of each frame, correspond to the parallax related information. Then, parallax adjustment may be carried out by using these parallax related information.

Further, the above first and second embodiments describe examples of cases in which the user is made to view the stereoscopic image by using the liquid crystal shutter glasses 14, and the above third embodiment describes an example of a case in which the user is made to view the stereoscopic image by using the lenticular sheet 42, but the present invention is not limited to the same. For example, the lenticular sheet 42 may be applied to the monitor 12A of the display device 12 described in the above first and second embodiments, and, by generating the stereoscopic image GR as described in the above third embodiment and displaying the stereoscopic image GR on the monitor 12A, the user can be made to view the stereoscopic image without using the liquid crystal shutter glasses 14. Or, instead of providing the lenticular sheet 42 at the monitor 307 of the compound-eye camera 301 described in the above third embodiment, the image G1 for the left eye and the image G2 for the right eye may be displayed alternately on the monitor 307, and the user may be made to view the stereoscopic image by using the liquid crystal shutter glasses 14 as described in the above first and second embodiments.

Further, although the above respective embodiments describe examples of acquiring the parallax amount on the basis of the face region of the same person, the present invention is not limited to the same. For example, the face region of a pet such as a dog or a cat or the like, or the contour of a characteristic portion of a specific animal or plant, or the contour of a characteristic portion of an object other than a living being (e.g., an automobile, a train, a building or the like) may be applied as the object of acquisition of the parallax amount. In this case, the example can be given of a form in which an image dictionary for pattern matching, in which are stored characteristic amount data expressing the characteristics of images of objects of acquisition, is stored in advance, and an object of acquisition is specified by using this image dictionary, and the parallax amount of the specified object of acquisition is computed. Note that the image dictionary is preferably a dictionary of a form that is customized by the user. In this case, the example can be given of an image dictionary, that is such that a user can additionally register into the image dictionary of characteristic amount data expressing characteristics of images showing objects that are designated as objects of acquisition of the parallax amount, and is such that the user can delete from this image dictionary.

Further, the object of acquisition of the parallax amount may be a subject that is based on a region (a closed curve region) that is surrounded by a closed curve that is prescribed by a spatial frequency (edge component) of a predetermined value per frame, or may be a subject that is based on a closed curve region that is prescribed by the spatial frequency of a spatial frequency (a predetermined value) that exceeds a predetermined spatial frequency per frame. Note that this subject may be the closed curve region itself that is prescribed by a spatial frequency that is greater than or equal to a predetermined spatial frequency within the frame, or may be a region within a geometric shape such as the smallest rectangle or smallest circle or the like that surrounds a closed curve region that is prescribed by a spatial frequency of a predetermined value, or may be a region that is obtained by deforming a closed curve region in accordance with a predetermined algorithm. In this way, the object of acquisition of the parallax amount may be any object provided that it is a predetermined subject per frame.

Note that the disclosure of Japanese Patent Application (Patent Application No. 2010-149859) in its entirety is incorporated by reference in the present Description.

Further, all of the documents, patent applications and technical standards described in the present Description are incorporated by reference into the present Description to the same extent as if the individual document, patent application or technical standard was concretely and individually indicated to be incorporated by reference.

What is claimed is:

1. A playback device comprising:

an input section that inputs continuous frame images of a plurality of viewpoints in which a same subject has been picked-up in continuous frames from a plurality of viewpoints;

a parallax amount acquiring section that acquires a parallax amount of a predetermined object on the basis of a frame image for a left eye and a frame image for a right eye that structure the continuous frame images inputted by the input section;

an abnormality judging section that judges, with respect to each pair of frame images that is a pair of the frame image for the left eye and the frame image for the right eye, that there is an abnormality in the parallax amount in a case in which an object of acquisition of the parallax amount can no longer be detected from the frame image for the left eye and the frame image for the right eye;

a parallax adjusting section that, when it is judged by the abnormality judging section that there is no abnormality in the parallax amount, with respect to the each pair of frame images, carries out parallax adjustment of the predetermined object, and that, when it is judged by the abnormality judging section that there is an abnormality in the parallax amount, with respect to the each pair of frame images, carries out parallax adjustment with respect to another object that is different than the predetermined object, and that, when it is judged by the abnormality judging section that there is an abnormality in the parallax amount, the parallax adjusting section lowers a parallax adjustment frequency; and

an output section that, when it is judged by the abnormality judging section that there is no abnormality in the parallax amount, outputs the frame image for the left eye and the frame image for the right eye that include the predetermined object on which parallax adjustment has been carried out by the parallax adjusting section, and that, when it is judged by the abnormality judging section that there is an abnormality in the parallax amount, outputs the frame image for the left eye and the frame image for the right eye that include the other object on which parallax adjustment has been carried out by the parallax adjusting section.

2. The playback device of claim **1**, wherein the parallax adjusting section makes an object, that has a closest distance to the predetermined object in a direction orthogonal to an image plane of the frame image for the left eye and the frame image for the right eye, be the other object.

3. The playback device of claim **1**, wherein the parallax adjusting section makes an object, that has a closest distance to the predetermined object in an image plane of the frame image for the left eye and the frame image for the right eye, be the other object.

4. The playback device of claim **1**, wherein at least one of the predetermined object or the other object is a subject image that is based on a closed curve region prescribed by a spatial frequency of a predetermined value within the frame image for the left eye and the frame image for the right eye.

5. The playback device of claim **1**, further comprising a display section that displays the frame images, that are outputted by the output section, such that the frame image for the left eye and the frame image for the right eye are viewed as a stereoscopic image.

6. A compound-eye image pickup device, comprising:

the playback device of claim **1**; and

an image pickup section that generates the continuous frame images by picking-up a same subject from a plurality of viewpoints in continuous frames.

7. A playback method comprising:

inputting continuous frame images of a plurality of viewpoints in which a same subject has been picked-up in continuous frames from a plurality of viewpoints;

acquiring a parallax amount of a predetermined object on the basis of a frame image for a left eye and a frame image for a right eye that structure the inputted continuous frame images;

judging, with respect to each pair of frame images that is a pair of the frame image for the left eye and the frame image for the right eye, that there is an abnormality in the parallax amount in a case in which an object of acquisition of the parallax amount can no longer be detected from the frame image for the left eye and the frame image for the right eye;

when it is judged that there is no abnormality in the parallax amount, with respect to the each pair of frame image, carrying out parallax adjustment of the predetermined object, and, when it is judged that there is an abnormality in the parallax amount, with respect to the each pair of frame image, carrying out parallax adjustment with respect to another object that is different than the predetermined object, and that, when it is judged that there is an abnormality in the parallax amount, carrying out parallax adjustment by lowering a parallax adjustment frequency; and

when it is judged that there is no abnormality in the parallax amount, outputting the frame image for the left eye and the frame image for the right eye that include the predetermined object on which the parallax adjustment has been carried out, and, when it is judged that there is an abnormality in the parallax amount, outputting the frame image for the left eye and the frame image for the right eye that include the other object on which the parallax adjustment has been carried out.

8. A non-transitory computer readable medium storing a program for causing a computer to function as:

an input section that inputs continuous frame images of a plurality of viewpoints in which a same subject has been picked-up in continuous frames from a plurality of viewpoints;

a parallax amount acquiring section that acquires a parallax amount of a predetermined object on the basis of a frame image for a left eye and a frame image for a right eye that structure the continuous frame images inputted by the input section;

an abnormality judging section that judges, with respect to each pair of frame images that is a pair of the frame image for the left eye and the frame image for the right eye, that there is an abnormality in the parallax amount in a case in which an object of acquisition of the parallax amount can no longer be detected from the frame image for the left eye and the frame image for the right eye;

a parallax adjusting section that, when it is judged by the abnormality judging section that there is no abnormality in the parallax amount, with respect to the each pair of frame image, carries out parallax adjustment of the predetermined object, and that, when it is judged by the abnormality judging section that there is an abnormality in the parallax amount, with respect to the each pair of frame image, carries out parallax adjustment with respect to another object that is different than the predetermined object, and that, when it is judged that there is an abnormality in the parallax amount, carrying out parallax adjustment by lowering a parallax adjustment frequency; and

an output section that, when it is judged by the abnormality judging section that there is no abnormality in the parallax amount, outputs the frame image for the left eye and the frame image for the right eye that include the predetermined object on which parallax adjustment has been carried out by the parallax adjusting section, and that, when it is judged by the abnormality judging section that there is an abnormality in the parallax amount, outputs the frame image for the left eye and the frame image for the right eye that include the other object on which parallax adjustment has been carried out by the parallax adjusting section.

* * * * *